LAGRANGIAN STUDIES OF SUBMESOSCALE COHERENT VORTICES IN THE CALIFORNIA CURRENT SYSTEM

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LONG-TERM GOALS

Our long-term goal is to understand the kinematics and dynamics of the California Current System and to apply this knowledge to naval and maritime operations in Eastern Boundary Current regions.

SCIENTIFIC OBJECTIVES

Along the Central and Northern California coast, subsurface floats routinely encounter submesoscale coherent vortices. The occurrence of these vortices is common enough that they have an important role in the offshore transport of properties from the coastal zone to the deep sea. The specific objectives of this study are to determine (1) when, where and how these vortices are formed, and (2) their role in mixing and transporting equatorial and subarctic waters.

APPROACH

Our goals are accomplished through the collection of shipboard CTD and ADCP data in the Central California area, moored observations of currents, and subsurface (RAFOS) float measurements. This project launched triads of RAFOS floats in conjunction with mesoscale-resolving hydrographic surveys of the California Current off Central California.

WORK COMPLETED

In May 1999, a triad of RAFOS floats was launched in poleward flow over the outer continental slope between 35°N and 36°N. A second triad of floats is scheduled for launching in November 1999 in conjunction with a Naval Oceanographic Office survey of Central California waters. Four of the seven floats that were launched in 1997 surfaced (the other three are scheduled to surface in December 1999). One of these was recovered off Newport, Oregon. These data were processed and the floats navigated. Sources off Pt. Arguello, Moss Landing, and Cape Mendocino were monitored using the NPS Ocean Acoustic Observatory at Point Sur. A new source was placed on Hoke seamount in May 1999 and is also monitored at Point Sur.

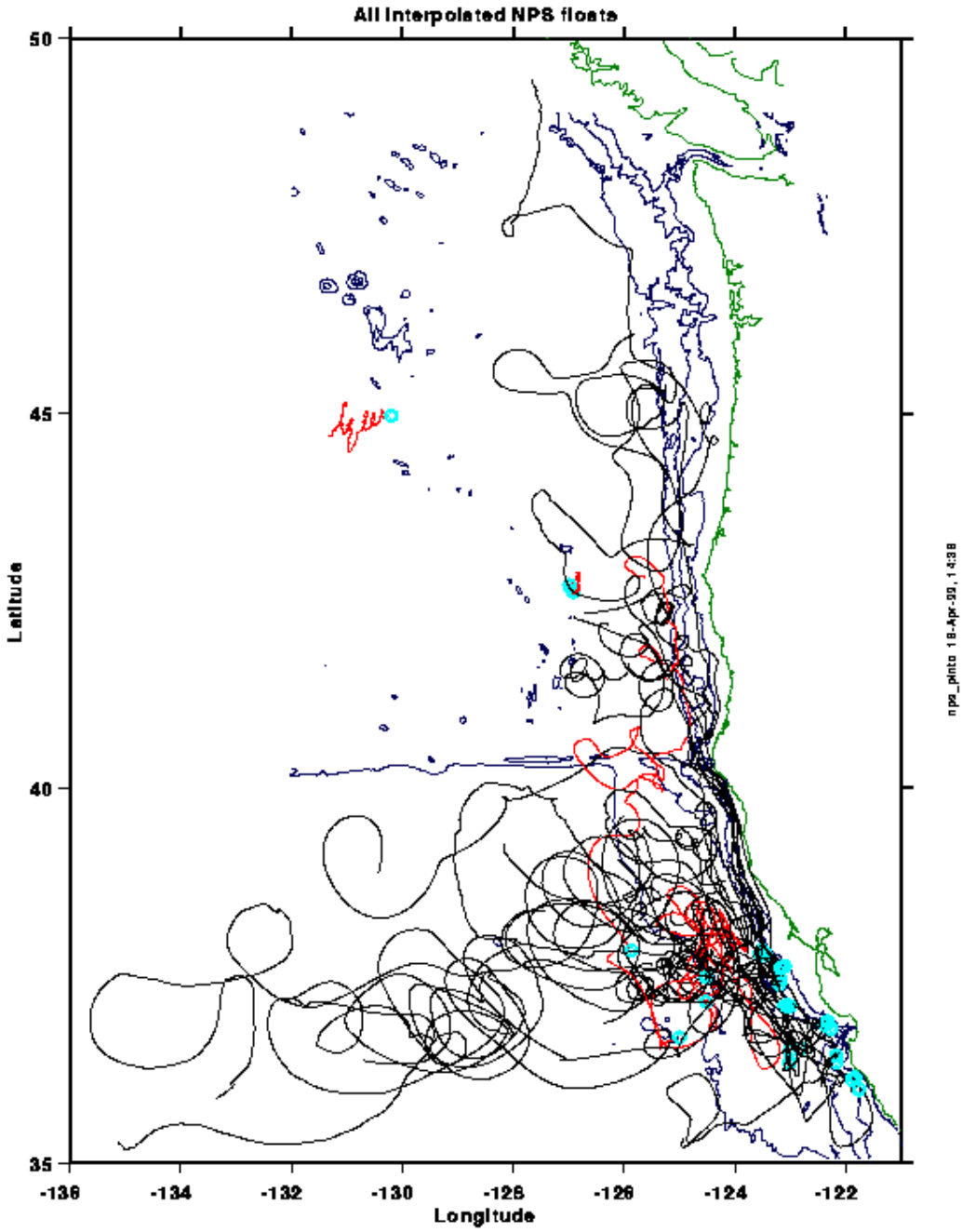

Figure 1. Trajectories for NPS RAFOS floats, 1992-1998. Red trajectories are for deep (1500-2500 dbar) floats and black trajectories are for intermediate (100-600 dbar) level floats. Cyan dots indicate launch locations. Dark blue lines are the 1000, 2000, 3000, and 4000 m isobaths.

Results from 1992-5 (Garfield, et al., 1999) have been updated to include 1996-8 trajectories and were presented at the 1998 Liege conference. As part of this effort, float trajectories were compared with numerical trajectories generated by an eddy resolving ocean circulation model.

RESULTS

In contrast to 1997-8, float trajectories for 1998-9 indicated poleward flow around Point Sur to Cape Mendocino. At Cape Mendocino, one float moved offshore and the others continued to move poleward, surfacing off Washington at the end of their missions. Comparison with model results indicate that the model now reproduces the poleward flow but fails to reproduce the eddies, offshore flow, and the observed single-particle diffusivities.

Figure 1 shows the trajectories for all floats that were tracked during the period 1992-8. Trajectories exhibited three patterns: poleward flow in the undercurrent; reversing, but predominately alongshore, flow adjacent to the continental margin; and, farther offshore, anticyclonic motion accompanied by slow westward drift. Flow continuity of the undercurrent existed between Pt. Reyes and at least Cape Mendocino with an average speed dependent upon float depth. Although speeds were variable, common features were acceleration to the south of Pt. Arena and deceleration to the north of Cape Mendocino.

IMPACT/APPLICATIONS

The view of the interior flow field for the eastern boundary derived from these float trajectories is markedly different from that presented in most text books. The eddy field provides an important mechanism for transport of water from near the coast to the interior of the Northeastern Pacific Ocean while the undercurrent transports equatorial waters poleward where they serve as source waters for coastal upwelling.

TRANSITIONS

The techniques and methods used to analyze these data have been applied to the development of tactical decision aids for mine warfare.

RELATED PROJECTS

Related projects involve analysis of shipboard observations of El Niño conditions along CalCOFI line 67, participation in Central California cruises sponsored by the Naval Oceanographic Office, and the use of RAFOS floats to track hydrothermal plumes in the region of Juan de Fuca Ridge. We collaborated with scientists at LANL to study the behavior of "numerical" floats in their high resolution numerical ocean model.

PUBLICATIONS

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Collins, C. A., N. Garfield, T. A. Rago, F. W. Rischmiller and E. Carter, 1999. Mean Structure of the Inshore Countercurrent and California Undercurrent off Point Sur, California. Deep-sea Res. II., in press.

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